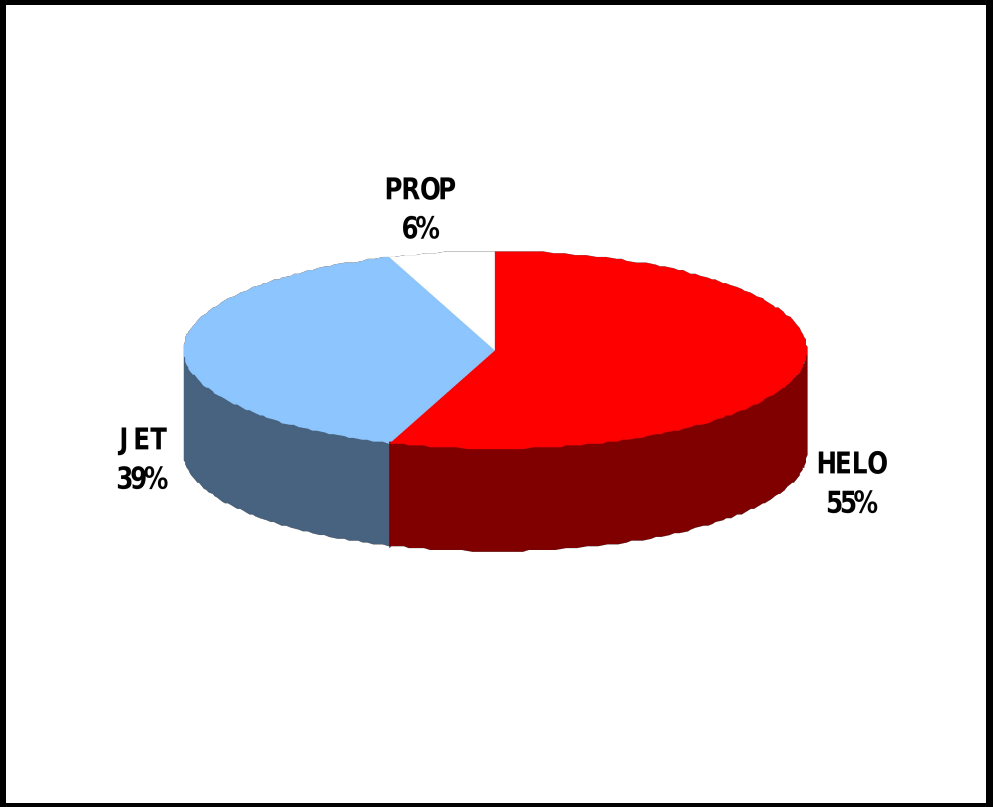
Sensory Physiology

FY00-07 = 18 Spatial Disorientation Episodes involved in a CAFM:

- **10 HELO:**
  - 3 CH-46E
  - 2 SH-60B
  - 2 CH-53E
  - 1 UH-1N
- **7 JET:**
  - 4 F/A-18C
  - 2 F/A-18D
  - 1 AV-8B
- **1 PROP:**
  - 1 E-2C



Spatial Disorientation

- When will SD most likely strike?
  - Degraded visual environment
  - Loss of reliable visual references
  - High cockpit workload
  - Poor mission planning / briefing
  - Lack experience (currency vs. proficiency)
  - Fatigue

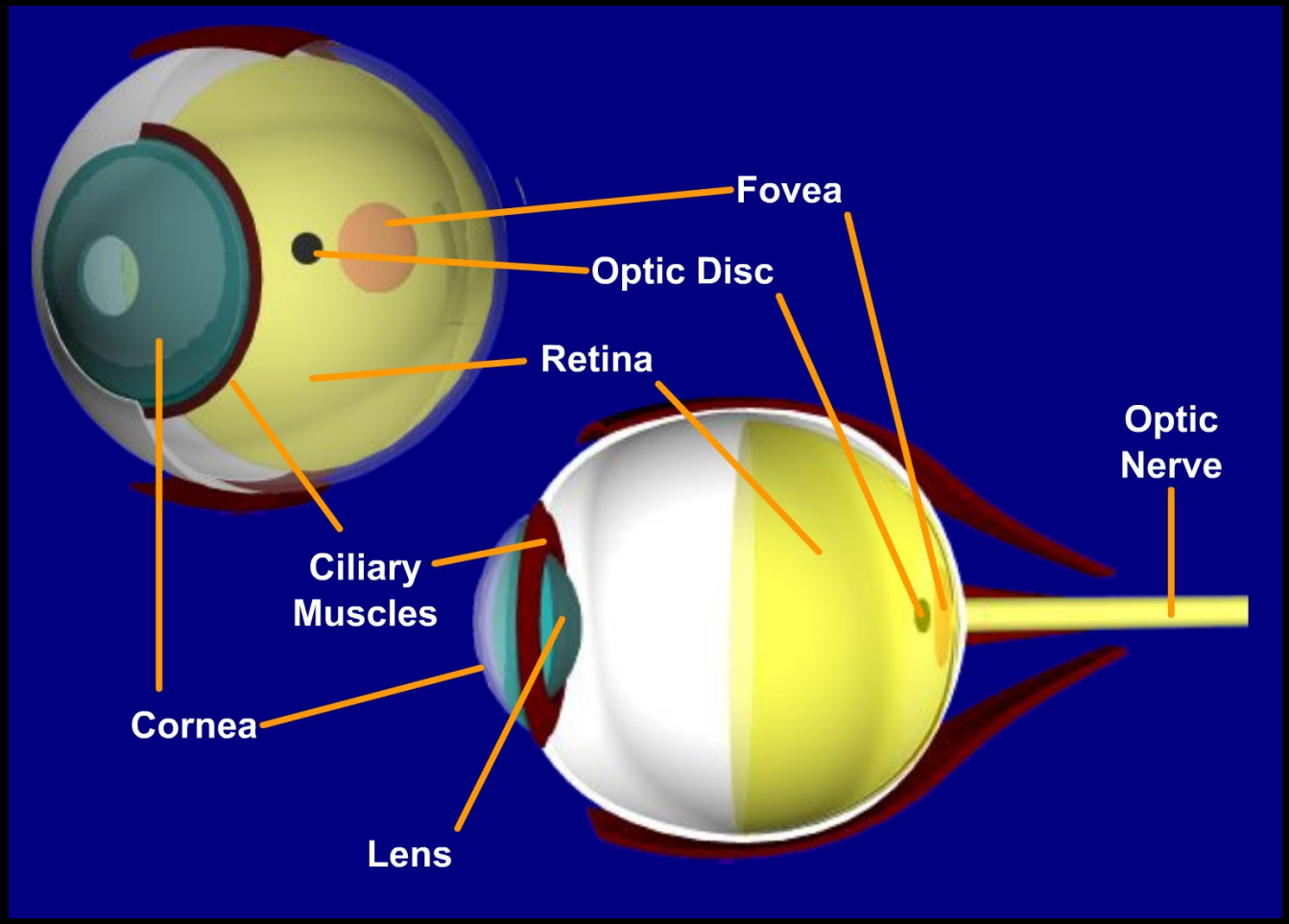
Spatial Disorientation

- Prevention
  - SCAN…SCAN…SCAN
    - Instrument scan
    - NVG scan
    - Unaided scan
  - Solid Mission planning
  - Attention to environmental changes
  - Proper rest

Spatial Disorientation

- Recovery
  - Re-establish visual/focal dominance (instrument cross-check)
  - “Make instruments read right”
  - Straight-and-level flight
  - Notify other crewmember or flight members (if applicable)

The Visual System

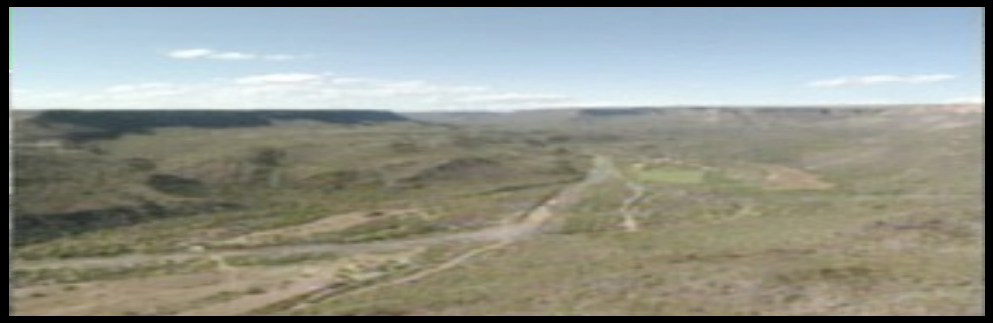


Day Vision vs. Night Vision

- Day Vision (Photopic)
  - Cone cells
- Night Vision (Scotopic)
  - Adaptation 20-30 min.
  - Rod cells
  - Night blind spot
- Mesopic Vision
  - Cone and Rod
  - Adaptation ~5-10 min.

Focal vs. Ambient Vision

- Focal Vision
  - “What”- Object recognition
  - Conscious
  - Detail
  - Distance & depth perception



- Ambient Vision
  - “Where”- Object location
  - Subconscious
  - Peripheral
  - Poor detail
  - Motion & Attitude

Focal vs. Ambient Vision

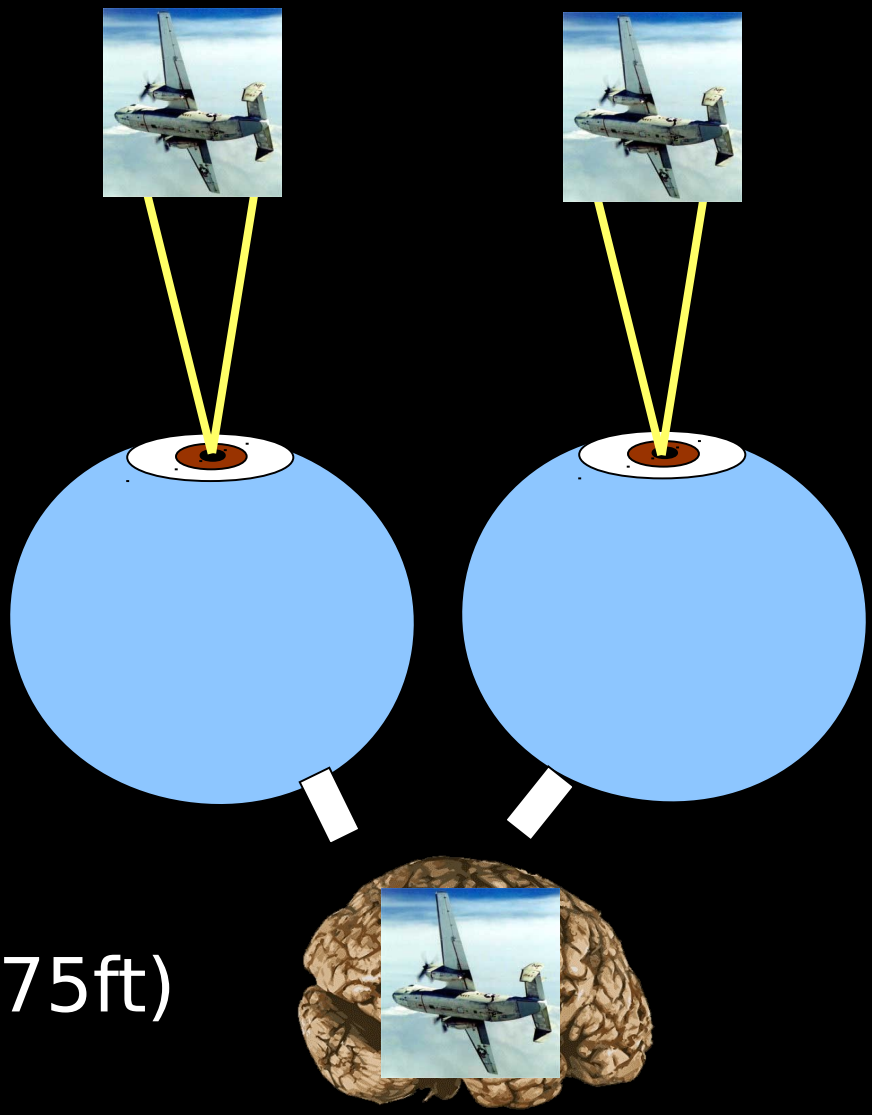
Focal Vision

VS.

Ambient Vision

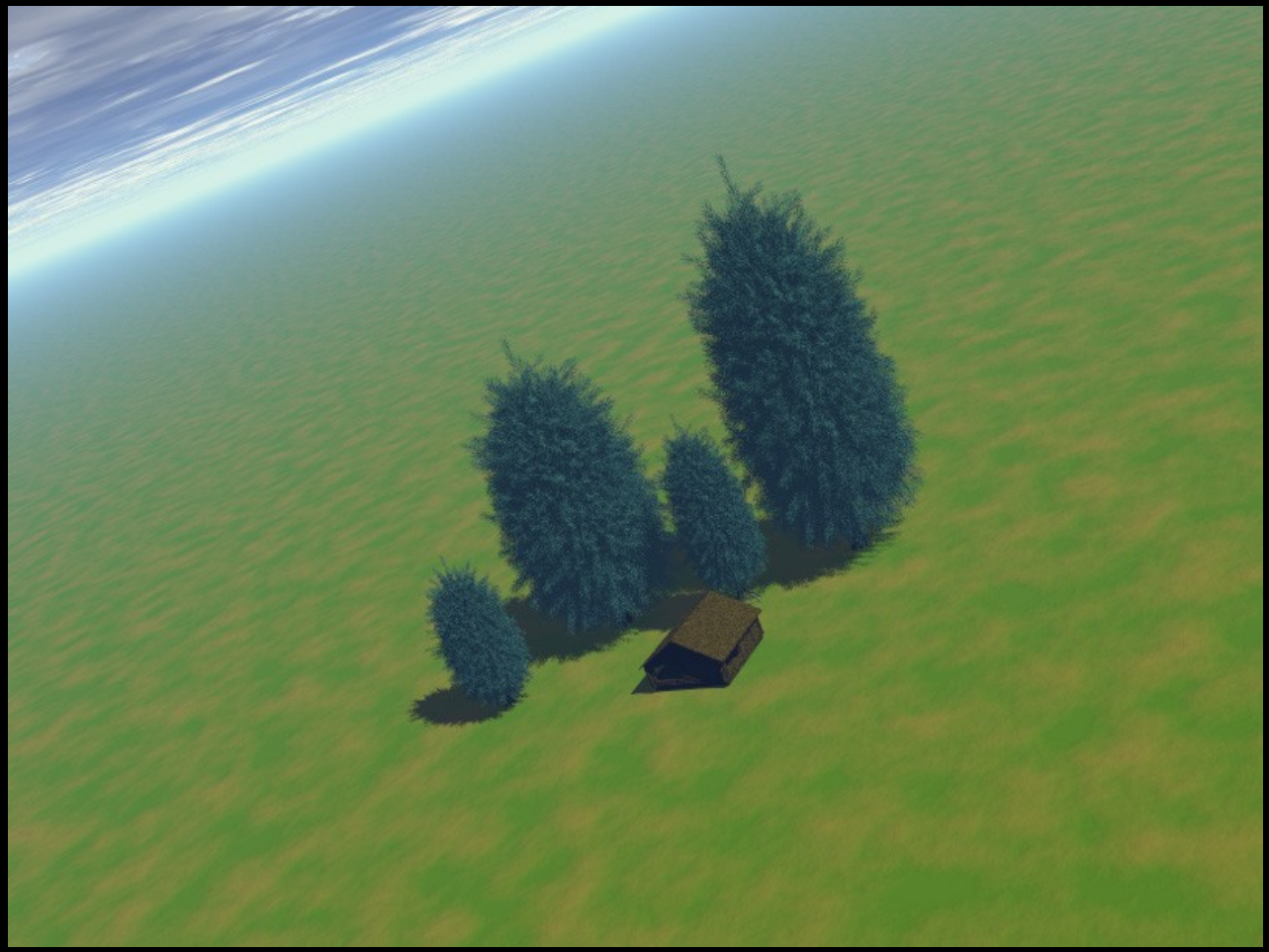
Spatial Discrimination

- Focal vision
  - Monocular
    - Learned
  - Binocular
    - Inherent
    - Depth
    - Distance
    - Stereopsis (375ft)



Size Reference Illusions

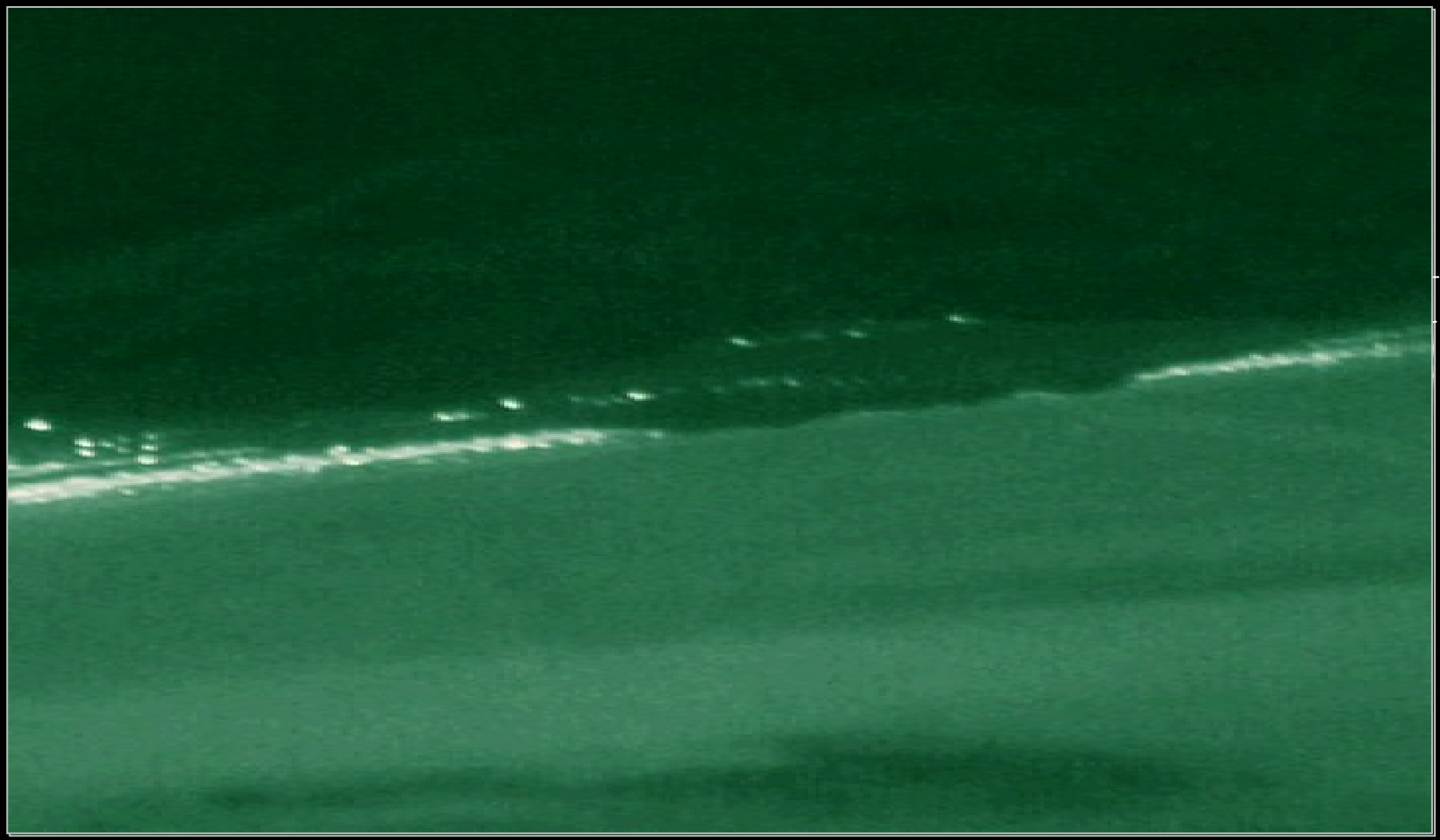
Size Reference Illusions



Size Reference Illusions

Size Reference Illusions

False Horizons



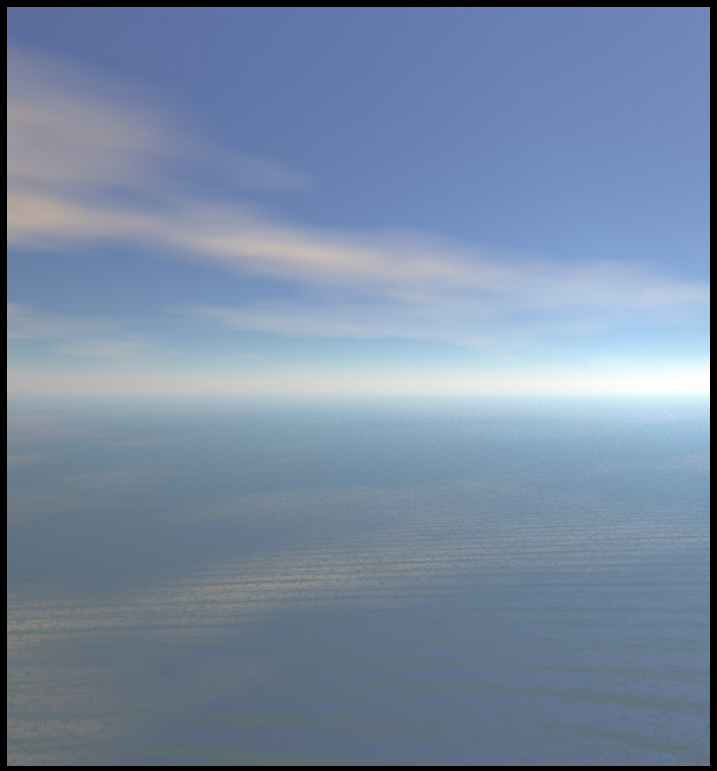
Wire Illusion Mishaps

1. All aircraft impacted left wing down
2. All pilots reported to detect wires rising
3. All pilots compelled to push the nose over and dive vice pulling back and climbing.

- **In 1998, EA-6B wire strike incident occurred in Northern Italy.**
- **In 1998, F/A-18 transiting through a CONUS low level navigation route struck a set of power lines.**
- **In 2003, F/A-18 stuck a power line over the Tennessee River Valley.**

• **In 2005, TH-57C severed three power lines located on Philpott Lake in the vicinity of Martinsville, Virginia during a training flight.**

Featureless Terrain



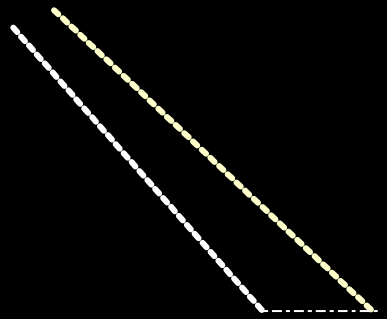
Can you use optical flow to judge?

Is cockpit workload increased?

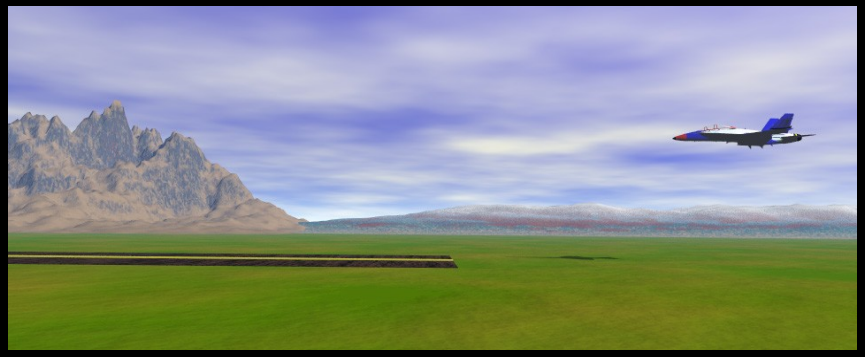
KC-130 Struck Berm

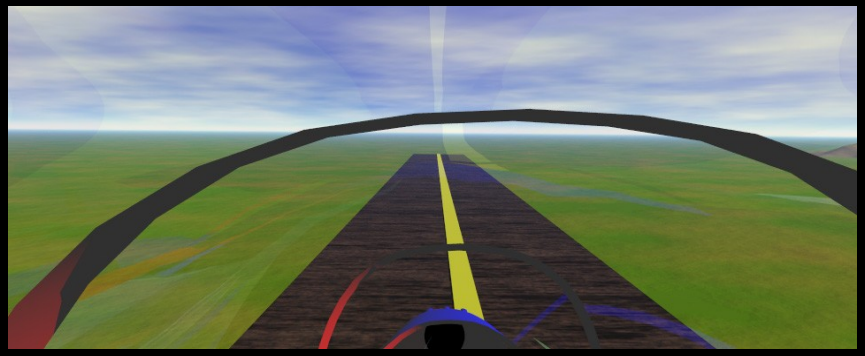
- KC-130 lands short to runway
- Up sloping unimproved surface that the aviator was unfamiliar
- No formal brief concerning the runway
- Pilot flew low flat glideslope
- Aircraft struck berm prior to runway waved off and conducted gear up landing

Black Hole Illusion



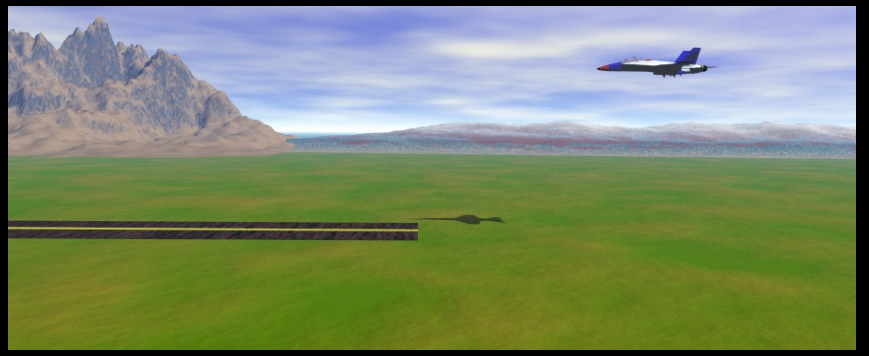
Runway Illusions

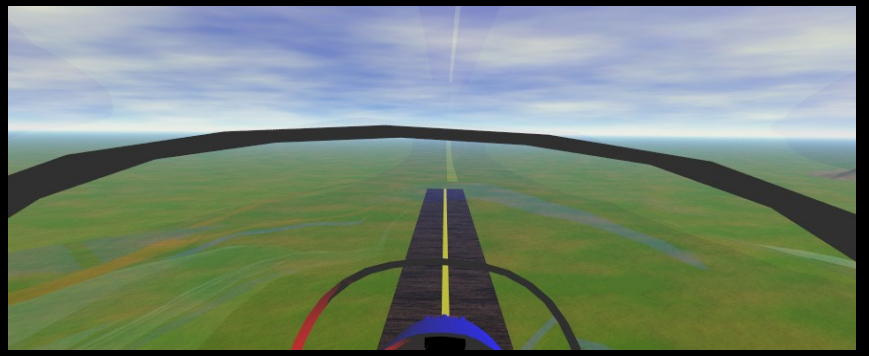




Low

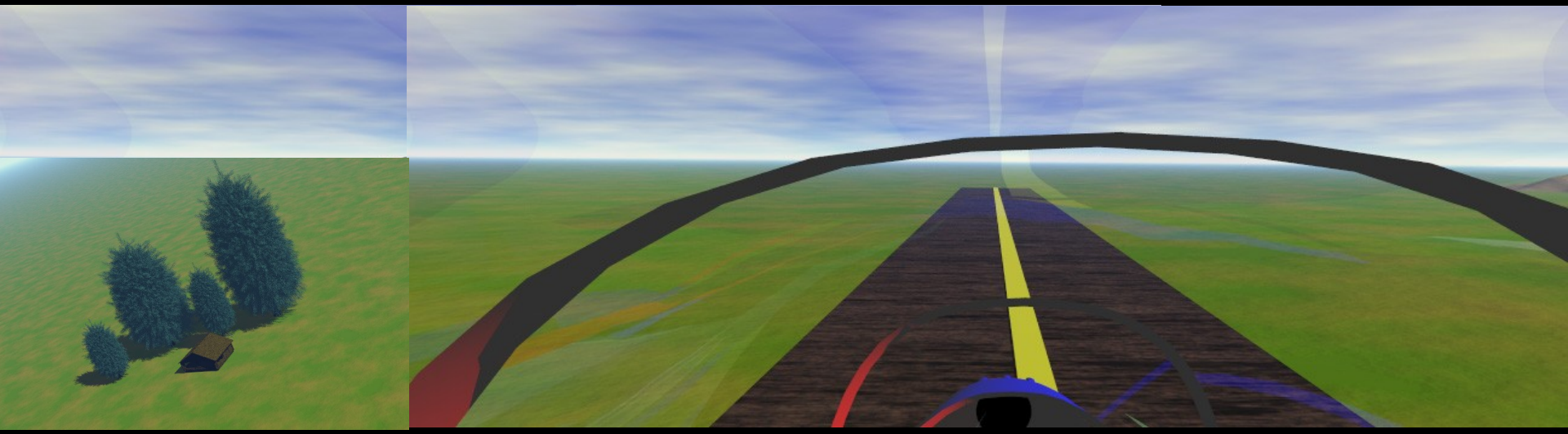
High



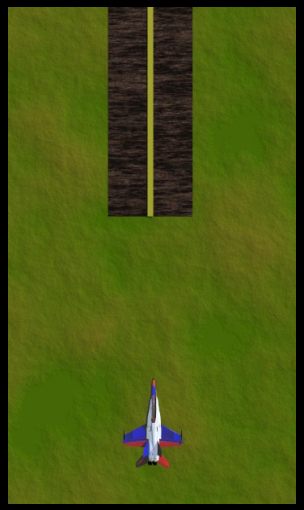


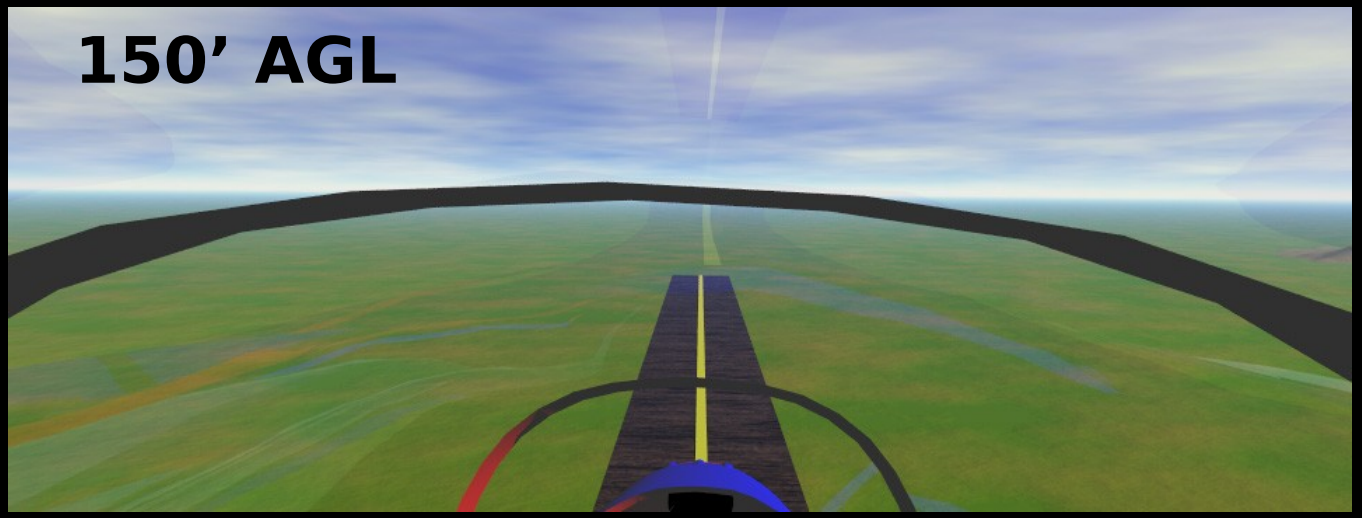
Runway Illusions

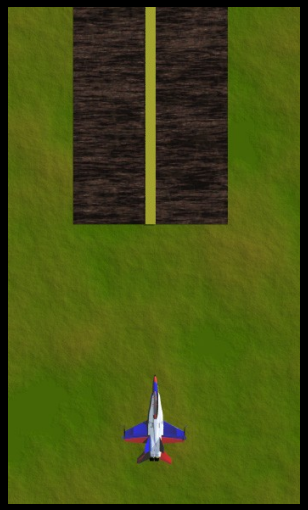
High or Low?

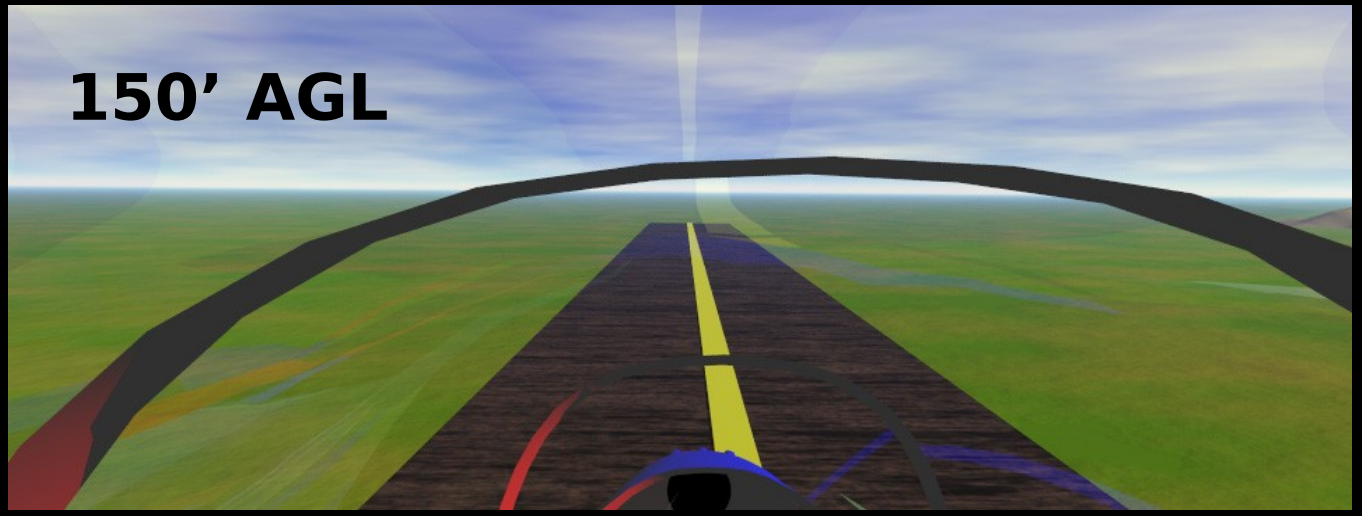


Runway Illusions





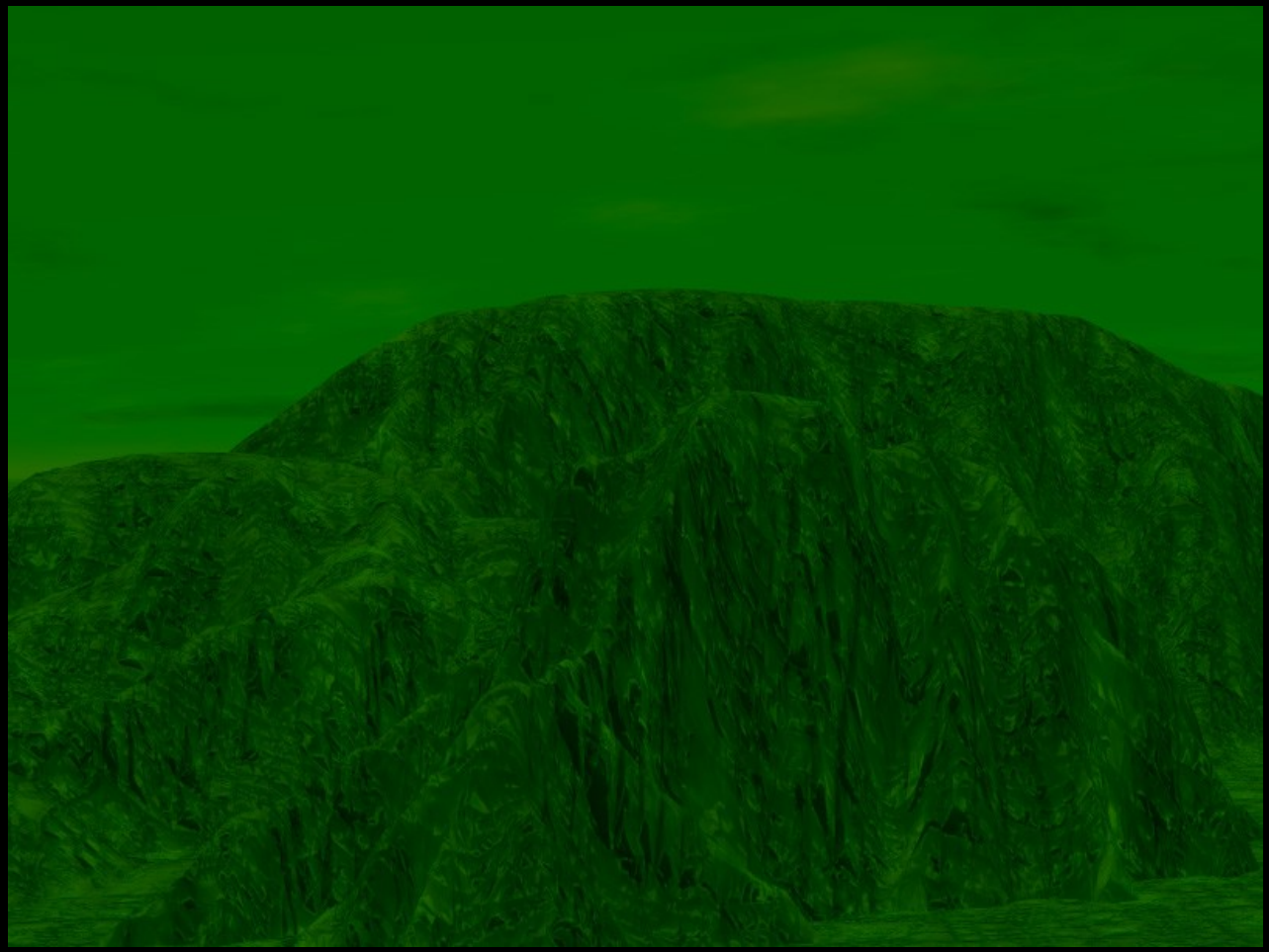




Too High or Too Low?

Terrain Masking

Terrain Masking

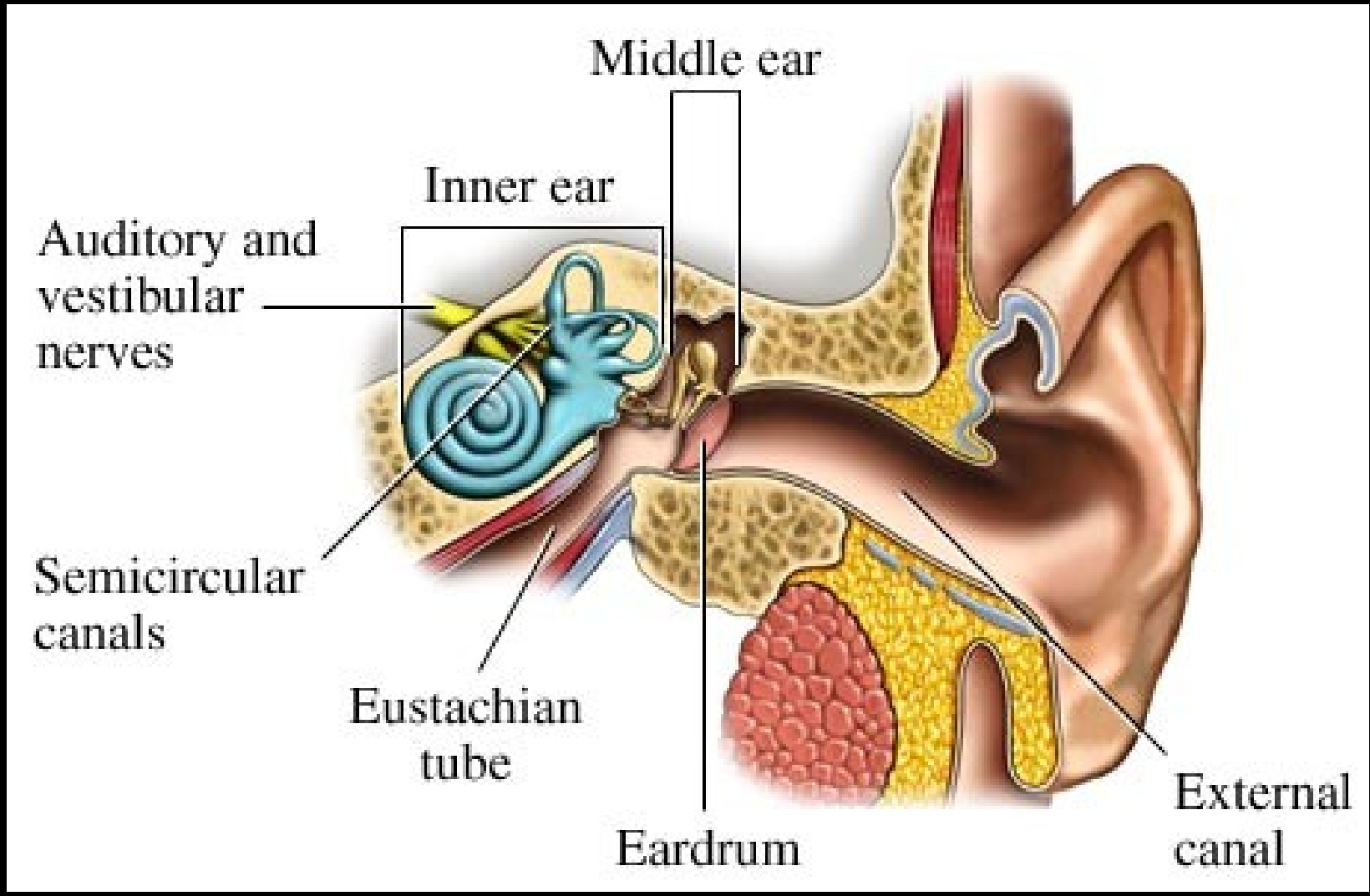


Terrain Masking

T-39 Class A Mishap

- CFIT
- Jan 10 2006
- VT-86
- NAS Pensacola
- TN
- 4 Crew
- Low level flight
- Possible Illusion

Vestibular System



Vestibular Illusions

- The “Leans”
- Coriolis Cross-coupling
- Nystagmus
- False Pitch Illusions
- G-Excess Illusion

F-18 Spatial D

- Dec 19 2006
- VFA-131
- CAS on NVG
- Night
- Overcast layer above cultural lighting in distance
- Pilot selected full left rudder trim to aid with target acquisition and forgot to re-center trim
  - Become accustom to unbalanced flight
  - Completed strafing run and pulled off target and verified positive rate of climb
  - Eyes came back inside cockpit.
  - Scanned instruments and noticed 45 degree pitch angle that felt nose high
  - HUD indicated altitude decreasing
  - Cultural lighting looked like the stars and overcast layer looked like the ground

False Pitch Illusion

Questions ?

LT Welsh